

**EARTH PENETRATING APPARATUS AND METHOD
EMPLOYING RADAR IMAGING AND RATE SENSING**

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ABSTRACT OF THE DISCLOSURE

An earth penetrating apparatus includes a cutting tool and a sensor housing. A radar unit, rate sensor unit, processor, and transmitter are provided in the sensor housing. An antenna arrangement is coupled to the radar unit and configured for transmitting and receiving electromagnetic signals in a relatively forward and/or lateral looking direction relative to a distal end of the cutting tool. The rate sensor unit may include one or both of a gyroscope and an accelerometer. The processor receives radar data from the radar unit indicative of subsurface strata and obstacles respectively located generally forward and/or lateral of the cutting tool, and receives displacement data from the rate sensor unit indicative of one or both of longitudinal and rotational displacement of the cutting tool. The transmitter is configured for transmitting one or both of the radar data and the displacement data to an aboveground location.